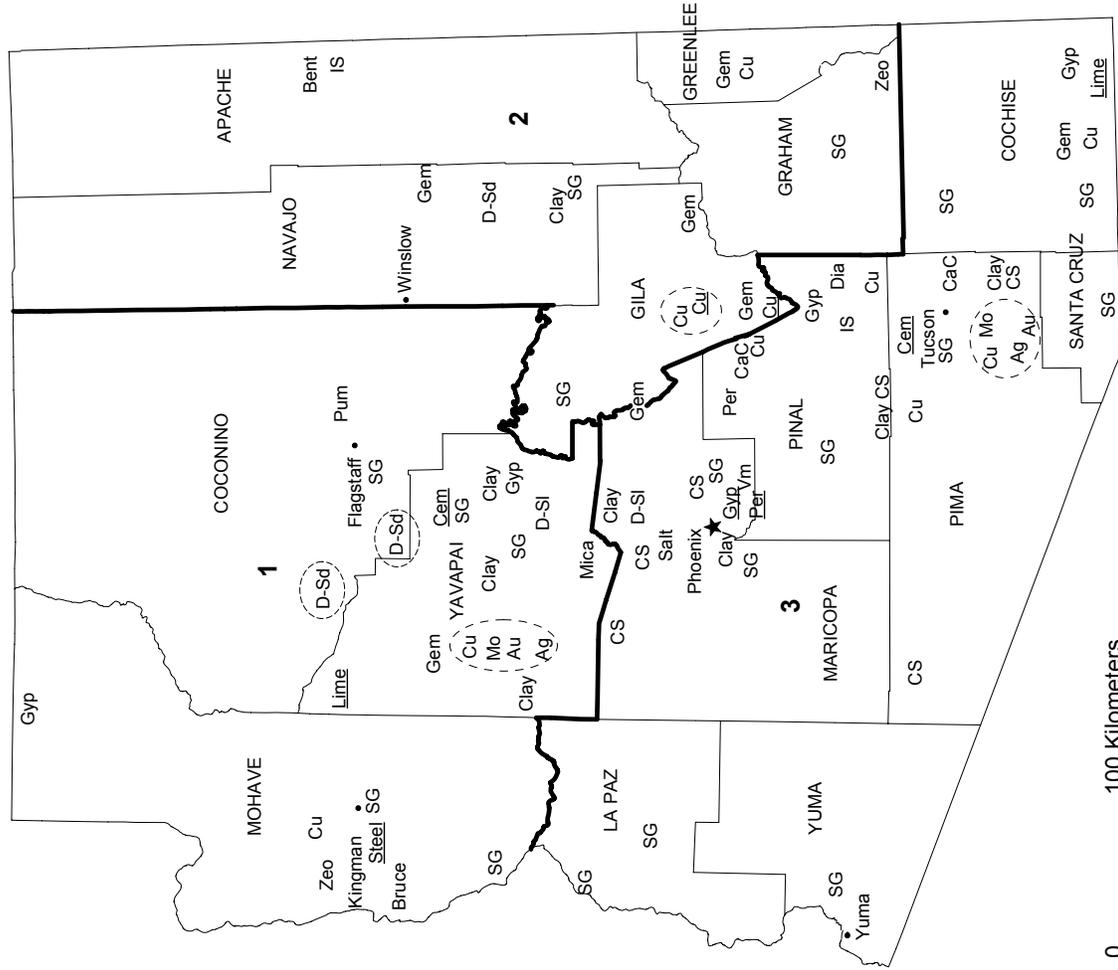


ARIZONA



LEGEND

- County boundary
 - ★ Capital
 - City
 - 1 — Crushed stone/sand and gravel districts
- MINERAL SYMBOLS (Major producing areas)**
- Ag Silver
 - Au Gold
 - Bent Bentonite
 - Bruce Brucite
 - CaC Calcium carbonate
 - Cem Cement plant
 - Clay Common clay
 - CS Crushed stone
 - Cu Copper
 - Cu Copper plant
 - D-Sd Dimension sandstone
 - D-Si Dimension slate
 - Dia Diatomite
 - Gem Gemstones
 - Gyp Gypsum
 - IS Industrial sand
 - Lime Lime plant
 - Mica Mica
 - Mo Molybdenum
 - Per Perlite
 - Per Perlite plant
 - Pum Pumice and pumicite
 - Salt Salt
 - SG Construction sand and gravel
 - Steel Steel plant
 - Vm Vermiculite
 - Zeo Zeolites
 - (---) Concentration of mineral operations

THE MINERAL INDUSTRY OF ARIZONA

This chapter has been prepared under a Memorandum of Understanding between the U.S. Geological Survey and the Arizona Department of Mines and Mineral Resources for collecting information on all nonfuel minerals.

In 2001, the estimated value¹ of nonfuel mineral production for Arizona was \$2.17 billion, based upon preliminary U.S. Geological Survey (USGS) data. This was about a 14% decrease from the \$2.51 billion of 2000,² and followed a 1% increase from 1999 to 2000. Arizona accounted for more than 5% of the U.S. total nonfuel mineral production and was fourth in the Nation in total nonfuel mineral production value.

Arizona continued in 2001 as the top copper-producing State, accounting for nearly two-thirds of total U.S. copper mine production and value. Copper was the State's leading nonfuel mineral, representing about 68% of Arizona's 2001 total nonfuel mineral production value. Both the quantity and the value of copper production decreased, owing to lower average copper prices and the scaling back of some operations. Construction sand and gravel was Arizona's second leading nonfuel mineral, followed by portland cement, molybdenum concentrates, and crushed stone. In 2000, copper mine production was down by about 12% owing to higher average copper prices; the value of production was up almost 3%. The increase in copper's value, about \$50 million, an \$8 million rise in construction sand and gravel, and a \$9 million increase in cement (portland and masonry combined) accounted for most of the increases in the State's nonfuel mineral commodity values in 2000. The largest decreases occurred in molybdenum concentrates, down more than \$20 million, silver, crushed stone, gypsum, and gold (table 1). All other changes were on the order of \$1 million or less—relatively inconsequential to the State's overall change in value. (Listings of mineral commodities are in descending order of value, magnitude of change in value, or quantity produced.)

Based upon USGS estimates of the quantities produced in the 50 States during 2001, Arizona remained the leading State in molybdenum output; second in gemstones; third in perlite; fourth in construction sand and gravel, silver, and zeolites; fifth

¹The terms "nonfuel mineral production" and related "values" encompass variations in meaning, depending upon the minerals or mineral products. Production may be measured by mine shipments, mineral commodity sales, or marketable production (including consumption by producers) as is applicable to the individual mineral commodity.

All 2001 USGS mineral production data published in this chapter are preliminary estimates as of August 2001 and are expected to change. For some mineral commodities, such as construction sand and gravel, crushed stone, and portland cement, estimates are updated periodically. To obtain the most current information, please contact the appropriate USGS mineral commodity specialist. Specialist contact information may be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals/contacts/comdir.html>; alternatively, specialists' names and telephone numbers may be obtained by calling USGS information at (703) 648-4000 or by calling the USGS Earth Science Information Center at 1-888-ASK-USGS (275-8747). All Mineral Industry Surveys—mineral commodity, State, and country—also may be retrieved over the Internet at URL <http://minerals.usgs.gov/minerals>.

²Values, percentage calculations, and rankings for 2000 may differ from the Minerals Yearbook, Area Reports: Domestic 2000, Volume II, owing to the revision of preliminary 2000 to final 2000 data. Data for 2001 are preliminary and are expected to change; related rankings may also change.

in pumice and pumicite; sixth in iron oxide pigments; seventh in bentonite; and eighth in dimension stone. The State rose to 10th from 11th in gold, and it continued to be a significant producer of portland cement, masonry cement, and lime.

The Arizona Department of Mines and Mineral Resources³ provided the following narrative information. Data may differ somewhat from data reported by the USGS in table 1.

It was a mixed year for mining in Arizona during 2001. A growing population and expanding transportation infrastructure continued to increase demand, and consequently provide markets for three commodities used in construction—sand and gravel, crushed stone, and cement. On the other hand, the State's largest and most important mining segment, the copper industry, was negatively affected by concerns about energy supplies and hit especially hard by very low copper prices. The U.S. producer cathode price was about \$0.77 per pound in 2001, \$0.88 per pound in 2000, and \$0.76 per pound in 1999 (Edelstein, 2002a).

Arizona's copper production has dropped about 30% from its peak of 1.25 million metric tons in 1997 to its current level of 875,000 metric tons (t) in 2001 (table 1). Average monthly employment figures over the 5-year period fell from a peak of 11,400 to 6,500 at the end of 2001, a 43% drop. Despite these declines, Arizona still remains as the leading copper-producing State in the Nation.

The Mission Complex, an open pit and underground copper mining operation composed of the Mission, Eisenhower, Pima, Mineral Hill, South San Xavier, and North San Xavier properties, is located near Sahuarita, AZ. ASARCO Incorporated (Grupo Mexico S.A. de C.V.) revealed plans to cut copper ore production by about 9,000 metric tons per day (t/d) (24%) and lay off about 110 employees at its Mission Mine in Arizona beginning on August 19. Copper production declined by a commensurate amount, or about 16,300 metric tons per year (t/yr). The cutback was attributed to the prevailing low copper prices (Edelstein, 2001). At the end of November 2001, Asarco announced a 23% curtailment in copper ore production owing to "poor market conditions," effective January 1. This was the second curtailment at Mission in 4 months, and a total cutback of 61% since November 2000. Production of copper in concentrate in 2002 was projected to decline to about 45,000 t, down from 115,000 t in 1999 (Edelstein, 2002b).

The Ray complex, near Hayden, AZ, consisted of the 225,000-t/d Ray open pit mine with a 27,000-t/d concentrator and a 47,000 t/yr solvent extraction-electrowinning operation, and the Hayden operations consisted of a 25,000-t/d concentrator and a 650,000-t/yr flash furnace smelter. Asarco processed higher

³Niemuth, N.J., Mining Engineer, authored the text of State minerals information provided by the Arizona Department of Mines and Mineral Resources.

ore grades at the Ray Mine that partly made up for cutbacks at the Mission Mine. The Ray Mine completed a bypass tunnel and other facilities that will achieve the water quality goals of a consent agreement with the U.S. Environmental Protection Agency. The project reduced haulage costs by shortening hauls and created space for leaching and waste dumps in the Mineral Creek area.

The Silver Bell Mine (Grupo Mexico S.A. de C.V. and Mitsui & Co.) produces about 50 t/d of copper cathode. It was located in Marana, AZ, and now operates with facilities inside the boundaries of the new Ironwood National Monument. Asarco sought to acquire 160 hectares through an exchange or boundary adjustment for continued use of an existing road, power/pipeline, and overburden storage. The roads have been in use since the early 1990s and the overburden in place since the 1960s. The Governor of Arizona, the U.S. Secretary of the Interior, and others discussed adjusting the boundaries of the Ironwood Monument, but no resolution was reached.

The Morenci complex, owned by Phelps Dodge Corp. and Sumitomo Metal Mining Arizona, Inc., was the largest copper-producing operation in North America. In March 2001, the mine-for-leach project was completed, converting Morenci production entirely to leach-solvent extraction-electrowinning. As a result of the improvement, the Morenci concentrator was placed on care-and-maintenance status (Phelps Dodge Corp., 2001).

In January 2001, Phelps Dodge issued Worker Adjustment and Retraining Notifications (WARN) to Sierrita employees due to uncertainty related to the availability and price of electrical power and the copper and molybdenum markets. The notices were renewed in March but expired in May without any layoffs. On January 15, 2002, Phelps Dodge announced a series of cutbacks. At Sierrita, it would reduce annual copper production by 45,000 t (50%) and affect 250 employees. Similarly, at Bagdad, annual production was to fall 64,000 t (50%) and affect 250 employees. Miami would temporarily close by January 15, 2002, eliminating 45,000 t of production and resulting in the layoff of 220 workers. Although the Miami smelter would continue to operate, the refinery temporarily closed affecting an additional 70 employees.

Also, in October 2001, Phelps Dodge and Placer Dome signed a joint-venture agreement to develop pressure-leaching technology for base-metal and precious-metal sulfide concentrates. In January 2002, a construction of a pilot demonstration plant to be built at Bagdad was announced. The \$40 million plant was to process 15% of Bagdad's concentrates, about 150 t/d, into cathode copper.

Three other companies also were negatively affected by the depressed metal prices and stock markets. AMT International Mining Corp. had difficulty raising funds to continue its Copper Creek project. It gave a deed in lieu of foreclosure to the owners of Ryland Ranch. The property was planned to host surface facilities for the mineral processing plant. Nord Resources Corp. filed a Chapter 11 reorganization case for the purpose of enabling it to develop its Johnson Camp Mine. Mercator Minerals Ltd. failed to complete its acquisition of the Mineral Park Mine. Equatorial Mining Ltd. retained ownership

and continued to operate the Mineral Park solvent-extraction leach plant.

Stirling Bridge Cement Co. proposed a new 270,000-t/yr portland cement plant and limestone quarry north of Prescott. The proposed quarry lies within the Prescott National Forest, while the processing plant will be developed on private property. With drilling of the deposit completed, the company is currently preparing an environmental analysis. Rockland Materials, a Phoenix area sand, gravel, and ready-mix concrete producer, would likely use a large portion of the cement production as the two companies have a common owner. In January 2001, Rockland switched its entire fleet of ready-mix concrete trucks and mobile aggregate equipment to 100% soy-based biofuel. Operating about 120 heavy-duty diesel units, Rockland Materials is the only Arizona company to make a complete switch to biofuel. It also represents the largest commercial fleet in the United States to make the conversion. According to owner Grant Goodman, Rockland Materials will spend about \$300,000 more to run its fleet with a fuel consumption rate estimated at about 1.2 million gallons per year.

U.S. Borax Inc. explored for evaporites in the Verde Valley. In the same area, drilling by the Arizona Department of Transportation recently identified a lens of thenardite in the Camp Verde formation near the Arizona Route 260 and Interstate-17 interchange.

The Arizona State Legislature passed A.R.S. 37-205, which allows an applicant for mineral leases and sales, if not the successful bidder at auction, to be reimbursed for some costs by the winning party or the State Land Department if a lease or sale is not issued. These costs may include, among others, cultural and environmental assessments and engineering and geologic studies. It is hoped this law will encourage exploration on State lands.

The Arizona Corporation's Securities Division accused Xenolix Technologies Inc. of fraud in a stock promotion. The company had previously been known as Mariah International, Guildmark Industries, and M.G. Gold Corp. The commission alleged that the company had made unregistered offerings of stock at a time it was claiming "to have a patented technology that would extract gold and precious metals from the company's volcanic cinders property." The company agreed, along with other terms, to buy back shares from investors from placements made between 1997 and 1999.

References Cited

- Edelstein, D.L., 2001, Copper in August 2001: U.S. Geological Survey Mineral Industry Surveys, November 2001, 11 p.
- Edelstein, D.L., 2002a, Copper: U.S. Geological Survey Mineral Commodity Summaries 2002, p. 54-55.
- Edelstein, D.L., 2002b, Copper in October 2001: U.S. Geological Survey Mineral Industry Surveys, January, 11 p.
- Phelps Dodge Corp., 2001, Form 10-K—Fiscal year ending December 31, 2001: Securities and Exchange Commission, 91 p.

TABLE 1
NONFUEL RAW MINERAL PRODUCTION IN ARIZONA 1/ 2/

(Thousand metric tons and thousand dollars unless otherwise specified)

Mineral	1999		2000		2001 p/	
	Quantity	Value	Quantity	Value	Quantity	Value
Copper 3/	1,050	1,760,000	929 r/	1,810,000 r/	875	1,470,000
Gemstones	NA	1,950	NA	2,920	NA	2,670
Gold 3/ kilograms	786	7,080	W	W	W	W
Molybdenum concentrates metric tons	15,700	W	W	W	W	W
Sand and gravel:						
Construction	54,500	296,000	59,400	304,000	56,600	294,000
Industrial	268	3,720	W	W	W	W
Silver 3/ metric tons	183	30,900	132	21,200	W	W
Stone, crushed	8,970	53,900	8,030	48,200	7,000	43,300
Zeolites metric tons	(4/)	NA	(4/)	NA	(4/)	NA
Combined values of cement, clays (bentonite, common), gypsum, (crude), iron oxide pigments (crude), lime, mica (1999), perlite (crude), pumice and pumicite, salt, stone (dimension sandstone), and values indicated by symbol W	XX	334,000	XX	326,000 r/	XX	364,000
Total	XX	2,490,000	XX	2,510,000 r/	XX	2,170,000

p/ Preliminary. r/ Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined values" data. XX Not applicable.

1/ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

2/ Data are rounded to no more than three significant digits; may not add to totals shown.

3/ Recoverable content of ores, etc.

4/ Withheld to avoid disclosing company proprietary data.

TABLE 2
ARIZONA: CRUSHED STONE SOLD OR USED, BY KIND 1/

Kind	1999				2000			
	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value	Number of quarries	Quantity (thousand metric tons)	Value (thousands)	Unit value
Limestone	8 r/	4,580 r/	\$25,100 r/	\$5.48 r/	10	4,280	\$21,700	\$5.07
Granite	21 r/	1,900 r/	14,800 r/	7.78 r/	22	1,870	14,400	7.71
Marble	2	W	W	11.53	2	W	W	8.96
Sandstone and quartzite	2 r/	W	W	11.67 r/	2	W	W	5.00
Traprock	2	W	W	7.07	1	W	W	11.54
Volcanic cinder and scoria	7	232	917	3.95	6	113	464	4.11
Miscellaneous stone	8 r/	1,850 r/	10,200 r/	5.50 r/	12	1,530	8,990	5.90
Total or average	XX	8,970 r/	53,900 r/	6.01 r/	XX	8,030	48,200	6.01

r/ Revised. W Withheld to avoid disclosing company proprietary data, included in "Total." XX Not applicable.

1/ Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

TABLE 3
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 2000, BY USE 1/ 2/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Construction:			
Coarse aggregate (+1 1/2 inch):			
Riprap and jetty stone	39	\$345	\$8.85
Filter stone	24	130	5.42
Total or average	63	475	7.54
Coarse aggregate, graded:			
Concrete aggregate, coarse	W	W	6.73
Bituminous aggregate, coarse	28	280	10.00
Bituminous surface-treatment aggregate	W	W	12.70
Railroad ballast	52	460	8.85
Other graded coarse aggregate	389	3,150	8.09
Total or average	469	3,890	8.29

See footnotes at end of table.

TABLE 3--Continued
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 2000, BY USE 1/ 2/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Construction--Continued:			
Fine aggregate (-3/8):			
Stone sand, concrete	(3/)	(3/)	7.19
Stone sand, bituminous mix or seal	(3/)	(3/)	15.52
Screening, undesignated	(3/)	(3/)	5.50
Coarse and fine aggregates:			
Graded road base or subbase	123	717	5.83
Unpaved road surfacing	6	26	4.33
Terrazzo and exposed aggregate	467	6,180	13.24
Crusher run (select material or fill)	30	106	3.53
Other coarse and fine aggregates	8	28	3.50
Total or average	634	7,060	11.13
Other construction materials	6	105	17.50
Chemical and metallurgical:			
Cement manufacture	(3/)	(3/)	5.02
Lime manufacture	(3/)	(3/)	4.95
Other miscellaneous uses and specified uses not listed	35	183	5.23
Unspecified: 4/			
Reported	1,750	10,200	5.86
Estimated	1,100	5,700	5.38
Total or average	2,800	15,900	5.68
Grand total or average	8,030	48,200	6.01

W Withheld to avoid disclosing company proprietary data, included with "Other."

1/ Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

2/ Includes granite, limestone, marble, miscellaneous stone, sandstone, quartzite, traprock, and volcanic cinder and scoria.

3/ Withheld to avoid disclosing company proprietary data, included in "Grand total."

4/ Reported and estimated production without a breakdown by end use.

TABLE 4
ARIZONA: CRUSHED STONE SOLD OR USED BY PRODUCERS IN 2000, BY USE AND DISTRICT 1/ 2/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3		Unspecified districts	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Construction:								
Coarse aggregate (+1 1/2 inch) 3/	2	6	43	306	18	163	--	--
Coarse aggregate, graded 4/	--	--	W	W	W	W	--	--
Fine aggregate (-3/8 inch) 5/	W	W	W	W	--	--	--	--
Coarse and fine aggregate 6/	426	4,750	48	426	160	1,880	--	--
Other construction materials	6	105	--	--	--	--	--	--
Chemical and metallurgical 7/	W	W	--	--	W	W	--	--
Other miscellaneous uses 8/	--	--	--	--	35	183	--	--
Unspecified: 9/								
Reported	699	4,160	37	223	286	1,630	721	4,220
Estimated	230	1,200	--	--	820	4,400	--	--
Total	3,230	18,200	336	3,130	3,740	22,600	721	4,220

W Withheld to avoid disclosing company proprietary data, included in "Total." -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Includes granite, limestone, marble, miscellaneous stone, sandstone and quartzite, traprock, and volcanic cinder and scoria.

3/ Includes filter stone and riprap and jetty stone.

4/ Includes bituminous aggregate (coarse), bituminous surface-treatment aggregate, concrete aggregate (coarse), and railroad ballast.

5/ Includes screening (undesignated), stone sand (concrete), and stone sand (bituminous mix or seal).

6/ Includes crusher run (select material or fill), graded road base or subbase, terrazzo and exposed aggregate, and unpaved road surfacing, and other coarse and fine aggregates.

7/ Includes cement and lime manufacture.

8/ Includes other specified uses not listed.

9/ Reported and estimated production without a breakdown by end use.

TABLE 5
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 2000,
BY MAJOR USE CATEGORY 1/

Use	Quantity (thousand metric tons)	Value (thousands)	Unit value
Concrete aggregate (including concrete sand)	14,100	\$84,200	\$5.98
Plaster and gunite sands	191	2,080	10.88
Concrete products (blocks, bricks, pipe, decorative, etc.)	265	2,960	11.16
Asphaltic concrete aggregates and other bituminous mixtures	3,020	13,000	4.29
Road base and coverings 2/	4,400	21,100	4.79
Road stabilization (cement)	227	382	1.68
Fill	5,500	9,610	1.75
Snow and ice control	15	145	9.67
Railroad ballast	(3/)	5	10.29
Other miscellaneous uses	4,060	16,700	4.11
Unspecified: 4/			
Reported	22,300	127,000	5.67
Estimated	5,300	27,000	5.20
Total or average	59,400	304,000	5.12

1/ Data are rounded to no more than three significant digits, except unit value; may not add to totals shown.

2/ Includes road and other stabilization (lime).

3/ Less than ½ unit.

4/ Reported and estimated production without a breakdown by end use.

TABLE 6
ARIZONA: CONSTRUCTION SAND AND GRAVEL SOLD OR USED IN 2000, BY USE AND DISTRICT 1/

(Thousand metric tons and thousand dollars)

Use	District 1		District 2		District 3		Unspecified districts	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregate (including concrete sand)	701	6,540	377	2,610	13,000	75,000	--	--
Concrete products (blocks, bricks, pipe, decorative, etc.) 2/	57	559	45	373	355	4,100	--	--
Asphaltic concrete aggregates and other bituminous mixtures	W	W	W	W	2,060	9,020	680	1,500
Road base and coverings 3/	312	1,310	435	2,570	3,500	16,900	384	647
Fill	22	84	4,660	5,220	818	4,310	--	--
Snow and ice control	--	--	15	145	--	--	--	--
Railroad ballast	--	--	(4/)	5	--	--	--	--
Other miscellaneous uses	92	726	192	1,730	4,050	16,600	--	--
Unspecified: 5/								
Reported	3,590	19,100	156	822	18,100	106,000	461	763
Estimated	880	4,900	920	5,400	3,500	17,000	--	--
Total	5,660	33,200	6,800	18,900	45,400	249,000	1,530	2,910

W Withheld to avoid disclosing company proprietary data, included with "Other miscellaneous uses." -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Includes plaster and gunite sands.

3/ Includes road and other stabilization (cement and lime).

4/ Less than ½ unit.

5/ Reported and estimated production without a breakdown by end use.